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RESEARCH REPORT

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Impacts Of Dykes On Wetland Values in Vietnam's Mekong River Delta: A Case Study in the Plain of Reeds

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This study investigates the impact of proposals to reduce the height of dykes in Vietnam's Mekong River Delta. The proposals are designed to reduce wetland water levels to an environmentally sustainable level, however it has not been clear how this will affect farmers in the region. High dykes currently protect many farms from flooding and allow farmers to grow more food. The study uses the Tram Chim National Park and adjacent areas in the Plain of Reeds as a case study. It investigates the potential impact of the proposed changes on rice outputs. It also looks at the value of the improvements in environmental quality that the proposals should produce.

The study finds that far from there being a trade-off between conservation and rural development, the proposed changes could produce both an improvement in the Delta's ecology and provide a net benefit to society. This suggests that the proposed plans represent a win-win for both nature and for people and that, given that society as a whole will benefit, money should be made available to compensate individual farmers for any losses. The research findings suggest what level of compensation should be provided and highlight other areas for research.

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IMPACTS OF DYKES ON WETLAND VALUES IN VIETNAM'S MEKONG RIVER DELTA: A CASE STUDY IN THE PLAIN OF REEDS

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August, 2007

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EXECUTIVE SUMMARY

The construction of ad hoc dykes in Vietnam's Mekong River Delta has contributed to wetland degradation. To address this problem, proposals on the conversion from the current high dykes to low dykes have been made by wetland scientists. However, due to a lack of information on the impacts of dykes on wetland values, policy-makers do not have sufficient grounds to make informed decisions regarding alternative dyke management strategies.

This research predicts the impacts of the proposed dyke conversion on both market and non-market values in a case study of the Tram Chim Wetlands in the Plain of Reeds in the Mekong River Delta. For market values, it estimates the costs of the dyke conversion in the form of local farmers' reduced income from rice production, using a production function approach. For the non-market values, it estimates the benefits of the dyke conversion in the form of improved wetland biodiversity, using an environmental choice modelling technique. Although the park dykes of Tram Chim are the main focus of this study, the impacts of converting farm dykes in other areas in the Plain of Reeds are also examined here. The impacts of farm dyke conversion on farmers' incomes and wetland biodiversity benefits are examined using the same techniques as in the case of the Tram Chim park dyke conversion. The ultimate goal is to provide policy-makers with estimates of costs and benefits of the dyke conversion so that the right decisions in terms of social welfare can be made.

It was found that the proposed park dyke conversion of Tram Chim would reduce rice yield by 0.03 tonnes per ha per year or 1,500 tonnes per year for local farmers in an adjacent area of 50,000 ha around the park. This income loss of about USD 91,875 per year, together with compensation paid by the government for "farmer changing livelihood" costs (costs of adapting to new conditions/jobs after the dyke conversion) and engineering costs, brings the total costs of the proposed five-year program to USD 3.4 million. On the other hand, respondents are willing to pay for increased biodiversity values of Tram Chim resulting from the proposed changes in dyke and wetland management. The aggregated non-market values range from USD 3.94 million to USD 5 million, suggesting that the park dyke conversion can generate a net social benefit.

It was also found that the conversion from high to low farm dykes would reduce rice yields by 0.24 tonnes per ha per year or VND 0.98 million per household per year. In addition, it would reduce the income from livestock rearing. The estimated cost of the dyke conversion would be VND 15.4 million per household per year and VND 614 billion or USD 38.4 million for the whole MRD. On the other hand, the biodiversity values of all wetlands in the MRD were estimated at USD 41.7 million and USD 53 million for lower and higher bounds respectively. Therefore, the net social benefits would range from about USD 3.3 million to USD 14.6 million.

The willingness to pay (WTP) for wetland improvement through dyke conversion depends on several factors. Older, more educated and wealthier respondents have a higher WTP. Those living further away from the wetland site, having knowledge about the wetland, and having option and bequest values about the wetland also show a higher WTP. However, respondents have a lower WTP if they have visited the site. The WTP is also reduced by a short, neutral “cheap talk” script that explicitly tells the respondents about hypothetical bias problems and reminds them about their budget constraints and other wetlands in the region that would provide similar values for the respondents. Although cheap talk was found to reduce WTP, its effect was only observed in respondents living far from the site. More specifically, cheap talk made respondents more concerned about the negative impacts on local farmers. It was also found that there was no significant difference between the WTP of farming respondents and non-farming respondents.

This research has shed some light on the impacts of the proposed dyke conversion on wetland market and non-market values. Although further research is needed to provide more insights into the costs and benefits of these changes, the findings of the partial cost-benefit analysis conducted in this research suggest that wetland improvement resulting from the dyke changes can generate net benefits to society. In addition, this study contributes to research on the application of choice modelling in wetland non-market valuation in Vietnam which in turn can help policy-makers understand the non-market values of wetlands and make better decisions in terms of wetland management and sustainable development.

1.0 INTRODUCTION

1.1 Impacts of Dykes on Wetlands in the Mekong River Delta

The Ramsar Convention (1971) defines wetlands as "areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six meters" (Ramsar Convention Bureau 2004).

The largest area of wetlands in Vietnam is found in the Mekong River Delta (MRD). Under the Ramsar definition, about 90% of Vietnam's MRD or about 4.9 million hectares are wetlands (Vietnam Environmental Protection Agency, IUCN, and MWBP 2005). These wetlands can be broadly divided into two categories: inland and coastal wetlands. Inland wetlands are dominated by floodplain paddy fields, seasonally flooded grasses and *melaleuca* forest, while coastal wetlands are generally dominated by mangrove forest (Torell and Salamanca 2003). The wetlands have experienced serious loss and degradation over the past few decades (World Bank 2002).

One cause of the wetland degradation is the development of ad hoc dyke systems in the delta (Hashimoto 2001; Peterson and Bennett 2003). There are two main types of dykes: park dykes surrounding wetland protected areas and farm dykes surrounding villages and paddy fields. The park dykes were built by local authorities to maintain a high water level in the dry season for fire fighting and prevention. The farm dykes were constructed by local farmers with support from local governments to protect agricultural land, villages and other infrastructure from annual flooding (Vietnam Southern Institute of Water Resources Research 2003).

The development of dykes began in the early 1980s and proceeded rapidly in the late 1990s. Dykes were developed in seven MRD provinces - Dong Thap, An Giang, Kien Giang, Long An, Tien Giang, Vinh Long and Can Tho, with a total length of 21,416 km (Vietnam Southern Institute of Water Resources Research 2003). The height ranges from one to four meters. The dykes enclose a total area of 1,099,314 ha (about 27% of the MRD area). On this scale, the dykes cause large-scale impacts on hydrological conditions and hence on the wetlands in the region.

Dyke development proceeded without full consideration of the biophysical and economic impacts on wetlands and other ecosystems (Petersen and Bennett 2003). No environmental impact assessments or cost-benefit analyses were conducted before the dyke construction. As a result, the development of dykes was based primarily on information regarding their localized benefits and costs of construction. However, while some parts of the flood plain have benefited from becoming alienated from the Mekong River through avoidance of flood damage, by shunting flows elsewhere, the dykes have increased the damage caused by flooding in other areas and imposed costs due to infrastructure damage on others (Nha et al. 2004).

In addition, the dykes have reduced sedimentation, which contains highly productive soil nutrients, in embanked areas (Hoi 2005). Other costs result from prolonged inundation in some wetland areas such as the destruction of *eleocharis* grasses which are the favoured food of the Sarus cranes. This, together with changes in hydrological conditions, has reduced the number of this endangered bird species in the MRD (Hung 2004).

Furthermore, costs have arisen because the dykes have hindered the free movement of fish between channels and wetlands during over-bank flooding (Hashimoto 2001). The fish most vulnerable to these changes is the 'white' fish species, which spawn on the flooded delta plain but live within the channels during the dry seasons. One solution to wetland degradation is converting the current high dykes to low dykes (Hoi 2005; Tram Chim Management Board 2005).

1.2 A Case Study in Tram Chim, Plain of Reeds

The case study reported here was carried out in the Tram Chim National Park and its adjacent areas in the Plain of Reeds in the Mekong River Delta. Established as a national park in 1994, Tram Chim is a 9,000 ha wetland located in the Tam Nong District of Dong Thap Province (Figure 1). Tram Chim is a habitat for 127 plant species. It supports a large number of herons, egrets, storks, ibises, and some rare species such as black-necked storks, lesser adjutants and greater adjutants. Most notably, Tram Chim provides a habitat for the Sarus cranes, the endangered bird species listed in the World Conservation Union (IUCN) Red Book (UNDP/IUCN/MRC/GEF 2005). Due to its biodiversity value, it was the first wetland national park declared in Vietnam and has been nominated by the Vietnamese government to be a Ramsar wetland site (Buckton et al. 1999).

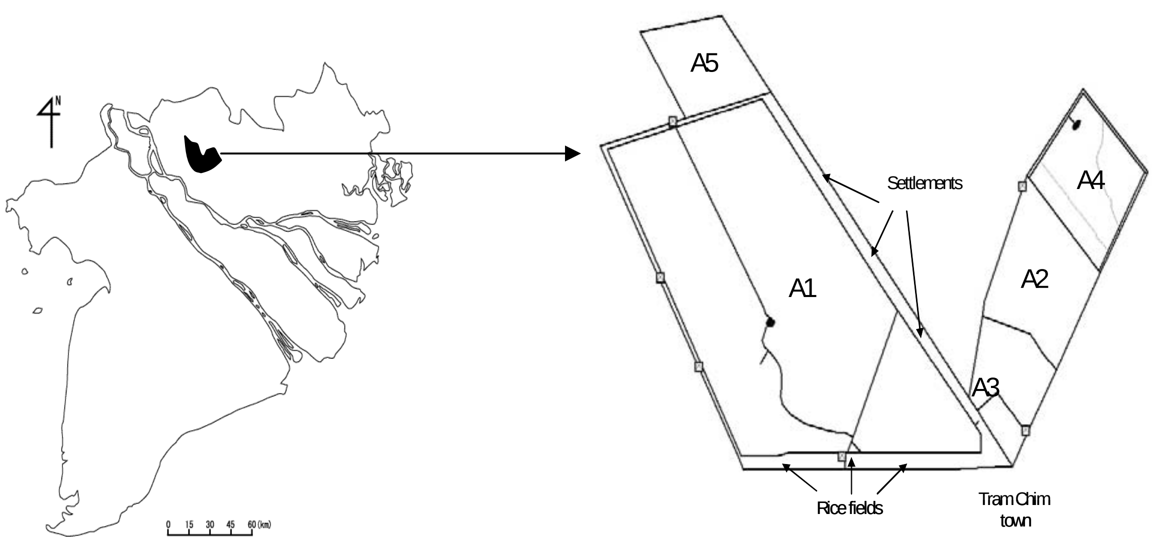


Figure 1. Location and Map of Tram Chim National Park

Note: The first picture shows the map of the MRD with Tram Chim National Park denoted in black. The second picture shows the map of Tram Chim National Park. Sections A1-A5 denote the zones in the park.

Tram Chim is enclosed by a 53-km dyke built in 1985 to retain water in the national park during the dry season. This helped restore the wetland ecological systems damaged during the Vietnam war (Pacovsky 2005). Evidence of ecological restoration came with the return of the Sarus crane. However, in 1996, to prevent fire, the local authorities raised the height of the dyke so much so the water level is now constantly higher than the ecological optimal level of 0.5m (UNDP/IUCN/MRC/GEF 2005).

The current park dyke system has affected Tram Chim's ecological system (Thanh 2003; Hung 2004). While the long inundation supports some deepwater aquatic species, overall, it has negative impacts on the ecological system. Native plants have been replaced by invasive *mimosa pigra* (Triet et al. 2004) while *eleocharis* or 'nang' grasses, the favourite food of the Sarus crane, have been destroyed. The latter has led to reduced numbers of this endangered bird species visiting the park (Figure 2). The dyke has also hindered fish migration and hence reduced the number of fish species living in the wetlands.

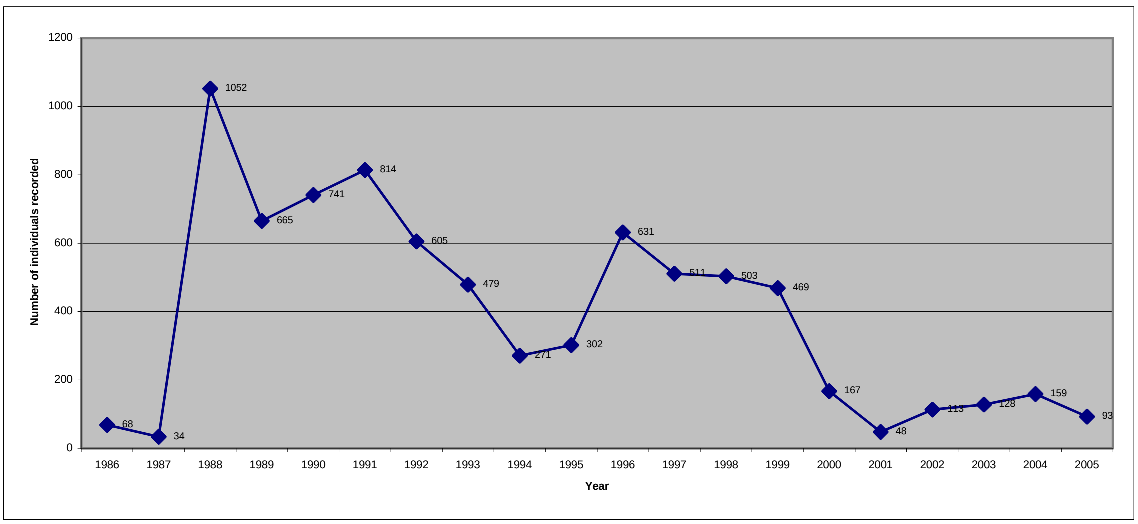


Figure 2. Number of Sarus Cranes Visiting Tram Chim (1986 – 2005)

To address this problem, the Park Management Board has proposed to change the current park dyke system and wetland management practices (Tram Chim National Park Management Board 2005). Changes in the park dyke will change water levels in farms in adjacent areas and hence can have impacts on farmers. It is estimated that a reduction in water level in the park by one meter can lead to an increase of 0.2 – 0.3 m of water in adjacent farms. This will have considerable impacts on farmers' farm dykes, cropping and livelihood due to prolonged flood durations. The changes in wetland management will involve improved vegetation control, increased hydrological and biological monitoring and stronger enforcement against illegal encroachments.

In addition, local authorities have proposed to convert farm dykes from high to low systems to improve other remnant wetlands in adjacent areas. This would negatively impact market values due to lowered rice output, but positively impact non-market value in terms of increased biodiversity.

Therefore, a case study focusing on the park dyke of Tram Chim and farm dykes in the adjacent areas in the Plain of Reeds would provide helpful inputs for decision-making involving dyke management in the whole region. More specifically, costs imposed on local farmers and benefits from wetland biodiversity improvement resulting from the proposed dyke conversion provide inputs for the cost-benefit analysis of dyke management alternatives for the MRD. The estimates of costs to local farmers are also helpful for determining the extent of any compensation to be paid to them.

1.3 Significance of the Study

At present, there is a lack of information on the linkages between the economic and biophysical impacts of dyke construction on wetlands. Some research projects (for example, Nha et al. 2004, and Vietnam Southern Institute of Water Resources Research 2003) have attempted to review the environmental and socio-economic impacts of the dykes. However, they failed to estimate changes in the non-market environmental values of wetlands and did not provide robust models that could predict wetland values under different dyke management scenarios.

Due to this information gap, debates about the impacts of the conversion from high to low dykes on wetland values have become a central issue in the management of the MRD. For farm dykes, some researchers believe that the current high dykes should be maintained due to their benefits to local farmers (Ni 2005; Kiet 2007) while others argue that these high dykes need to be converted to low dykes to minimise the negative impacts on the environment (Loi 2004; Nha et al. 2004). For park dykes, while it has been generally agreed that the existing high dykes needs to be lowered to improve natural wetland health (Thanh 2003; Phien 2005), the remaining question is whether the benefits from this conversion outweigh the costs. In short, it is unclear to policy-makers whether the changes in current dykes for both farm and park dyke systems would generate net social benefits.

To fill this gap, the research reported in this paper estimates impacts of changes in dykes on both market and non-market values. For the market values, it uses a production function (PF) to estimate the impacts on rice production. Using this production function, the costs of dyke conversion in the form of local farmers' reduced incomes from rice production are estimated. For the non-market values, the benefits of the dyke conversion in the form of improved wetland biodiversity are estimated, using an environmental choice modelling (CM) approach. The ultimate goal is to present to policy-makers, estimates of the costs and benefits of the proposed dyke conversion so that decisions can be made to improve social welfare. However, it should be noted that the changes in dykes may result in changes in other wetland values such as aquaculture and water purification, but estimating such impact values was not performed in this study due to the limited time frame. Therefore, the findings of this research should be considered as outputs of a partial cost-benefit analysis.

In addition, this research contributes to existing information on CM and wetland management by addressing three questions: 1) Are the values of wetland protection affected by the distance of beneficiaries from the wetlands? 2) Do biodiversity values differ between non-farming and farming populations? and 3) Does ‘cheap talk’[1] influence value estimates?

With regard to the first and second questions, a number of research projects have been conducted to test the effect of distance from the studied sites (for example, Sutherland and Walsh 1985; Pate and Loomis 1997) and between farming and non-farming populations on willingness to pay (WTP) (for example, Winter 2005). However, this kind of test has not been conducted in a developing country context. Therefore, the results of the test in this research will not only contribute to the literature on CM applications in Vietnam, but will also be helpful in policy-making involving the aggregation of WTP estimates for wetlands over a broad geographic scale.

In regard to the third question, while many studies conclude that using cheap talk can effectively eliminate hypothetical bias in the contingent valuation method (CVM) (for example, Cummings and Taylor 1999, and List 2001), few research projects have investigated this issue in CM. In addition, findings on the effects of cheap talk are mixed in both CVM (Poe et al. 2002; Aadland and Caplan, 2003) and CM (Carlsson et al. 2004; List et al. 2006). Furthermore, to this author’s knowledge, most cheap talk studies have been conducted in developed countries in very different contexts from developing countries. Therefore, a cheap talk test in a developing country like Vietnam would provide important insights into the context-dependent aspects of cheap talk effectiveness.

1.4 Research Questions

In this research, the following questions will be answered.

For market values

How do rice production values change when high dykes are converted to low dykes?

What are the distributional impacts of dyke conversion on rice production values?

For non-market values

How much are people willing to pay for increases in each wetland biodiversity attribute?

How much are people willing to pay for a proposed dyke conversion scenario?

What are the effects of distance and cheap talk scripts on value estimates in a CM application?

What is the difference in WTP for biodiversity values of farmers and non-farmers?

[1] 'Cheap talk' entails reading a script that explicitly highlights the hypothetical bias to respondents before they make any decisions (Murphy et al. 2005).

2.0 METHODOLOGY

This section reviews production function and choice modelling valuation techniques. It then discusses the development of questionnaires and survey implementation.

2.1 Valuation Techniques

Two techniques were used to estimate market and non-market values: Production Function (PF) and Choice Modelling (CM).

2.1.1 Production Function Approach

A static PF approach was used to estimate changes in producer surplus as a result of changes in dyke management. The impacts of dykes on rice values were derived by estimating the relationship between inputs and rice outputs for different dyke systems. Current market prices for rice outputs were used under the assumption that any changes in rice output in the Plain of Reeds would be insufficiently large to affect the market prices of inputs and rice. That is, it was assumed that resource use and prices, and thus consumer surplus remained constant. By using this approach, the effects of dyke management on rice profits were estimated.

A literature search on the relationship between rice production and water management regimes was conducted to make sure that relevant variables would be included in the farm survey questionnaire and to examine the suitability of existing rice production models for this research. It was found that there has been considerable research on this topic. One of the most sophisticated models used to simulate crop growth of lowland rice in water limited and potential production situations is the ORYZA 2000 model with 702 variables developed by the International Rice Research Institute (2004) (Tuong et al. 2003). Other models include those developed by Shi et al. (2002) and Kompas (2004).

However, none of these models included a dyke variable that could be used in this research. The ORYZA model has a water-stress variable but is unable to predict rice growth under different flooding scenarios to meet the objectives of this research. (B. Bouman, personal communication , January 10, 2006). While some other models (for example, Shi et al. 2002 and Lu et al. 2002), can predict rice production under different water schemes, the models analyze water levels in rice fields from 30 to 60 cm and do not take into account different flooding scenarios. Therefore, the models were not suitable for use in this research.

Two studies having objectives that were close to those of this research were the evaluation of the impacts of dykes on rice production in Bangladesh by Scullion (1996) and the assessment of environmental and socio-economic impacts of dykes in the Long Xuyen Quandrangle by Nha et al. (2004). However, neither of these studies specified the models they used. This information gap was confirmed by some members of the Resource Economic Network (RESECON) (Personal communication, January 10, 2006) after a query was sent by this author to the RESECON asking its members for their experience in this area. This again highlights the need for establishing a rice production model for different dyke management scenarios.

Among the rice production function models available in literature, the model developed by Kompas (2004) was deemed to be the most relevant to this research because it had been recently developed based on Vietnam's Mekong Delta data. For this research, this model was extended to include a dyke variable. The model takes the basic form:

$$Y = f(D, A, L, K, I)$$

where

Y is the output of rice (tonnes),

D is dyke height with two levels: low dykes and high dykes,

A is land inputs (ha),

L is labor input (human working hours),

K is capital input (machine working hours), and

I is a vector of material inputs such as seeds (kg), fertilizers (kg) and pesticides (ml).

Kompas (2004) and Nguyen (2006) suggest that a Cobb-Douglas functional form is appropriate for rice production in the MRD. This function is written as:

$$Y= e^{\alpha 1D} A^{\alpha 2}L^{\alpha 3}K^{\alpha 4}I^{\alpha 5}$$

where

e is the exponential function

Y, D, A, L, K are the same as in the above equation and

$\alpha 1$ is the coefficient of dykes,

$\alpha 2$ is the coefficient of land,

$\alpha 3$ is the coefficient of labor,

$\alpha 4$ is the coefficient of capital, and

$\alpha 5$ is the coefficient of material inputs.

Using a general log-linear specification, the above equation can be written as follows:

$$\ln(Y) = \alpha 1\, D + \alpha 2 \ln(A) + \alpha 3 \ln(L) + \alpha 4 \ln(K) + \alpha 5 \ln(I)$$

Based on this model, the effect of different dyke systems on rice yields was estimated. The effects of dykes on the marginal products of inputs were also estimated by examining the interactions between D (dyke height) and the inputs (A, L, K, and I).

2.1.2 Environmental Choice Modelling

Environmental choice modelling (CM) is an emerging stated preference technique for non-market valuation (Bennett and Blamey 2001). It involves asking survey respondents to choose their most preferred resource use option from a number of alternatives. CM estimates not only the value of changes in individual attributes but also the value of aggregate changes in environmental quality. While there are numerous stated preference techniques, including the CVM, contingent rating, contingent ranking, paired comparison and choice modelling, CM has the advantage of providing a rich data set, strategic bias reduction, benefit transfer potential, framing effect control and flexibility (Bennett and Adamowicz 2001).

CM is consistent with the Random Utility Theory (RUT) (Adamowicz et al. 1998; Louviere 2001). In RUT, utility is a latent construct that exists in the mind of the consumer but cannot be observed directly. By using CM, some of this unobservable consumer utility can be explained, while some proportion remains unexplained as shown in the following equation:

$$U_{an} = V_{an} + \varepsilon_{an}$$

where U_{an} is the latent, unobserved utility for choice alternative, V_{an} is the systematic, observable component of the latent utility, and ε_{an} is the random component of the latent utility associated with option *a* and consumer *n*. Because of the random component, it is impossible to understand and predict preferences perfectly. This leads to expressions of the probability of choice:

$$P(a/C_n) = P[(V_{an} + \varepsilon_{an}) > (V_{jn} + \varepsilon_{jn})$$

for all *j* options in choice set C_n

In other words, the probability of consumer *n* selecting option *a* from choice C_n is equal to the probability that the systematic and random components of option *a* for consumer *n* are greater than the systematic and random components of option *j* for consumer *n* in choice C_n. To estimate the choice probabilities using Multi-Nomial Logit (MNL), it is assumed that the random components are independently and identically distributed (IID) with the scale parameter μ. In this case, the probability is:

$$P(a/C_n) = \exp(\mu V_{an})/\sum \exp(\mu V_{jn}) \text{ where } j = 1,\ldots,C_n$$

To introduce respondent heterogeneity, socio-economic variables are used as independent variables in each equation. When the data do not support IID, MNL estimates might be biased. This triggers the use of nested logit, mixed logit or random parameter logit (RPL), and latent class models detailed in Louviere et al. (2000), Layton (2000) or Revelt and Train (1998), and Boxall and Adamowicz (2002) respectively. These models have been widely applied in estimating wetland values (Othman et al. 2004; Whitten and Bennett 2005; Birol et al. 2006).

Implicit prices for the attributes used to describe the choice alternatives are estimated on a *ceteris paribus* basis. That is, they are estimations of the WTP of respondents for an increase in the attribute of concern, given that everything else is held constant. Implicit prices for linear conditional indirect utility functions are determined using the following formula:

$$\text{Implicit price} = -(\beta_{\text{non-market attribute}} / \beta_{\text{monetary attribute}})$$

where β is the coefficient/s estimated in the MNL.

In addition to the estimation of values of individual attributes, the compensating surplus relating to a change in overall conditions can also be estimated using the following formula:

Compensating surplus $= - (1/\beta_{monetary}) (V_1 - V_2)$

where

V_1 is the value of the indirect utility associated with the status quo,

V_2 is the indirect utility associated with the specific levels of the attributes describing the changed resource allocation, and

β is the coefficient/s estimated in the MNL.

Two tests for comparing different models are proposed by Swait and Louviere (1993) and Poe et al. (2005). The former is used for testing differences in parameters of the models of interest. The latter involves a convolution test of differences across welfare measures derived from the models.

2.2 Questionnaire Development

2.2.1 Farm Survey

A draft PF farm survey questionnaire was developed based on previous studies on rice production in the MRD (Nguyen 2006; Kompas 2004). The questionnaire was pre-tested in 35 households in three villages in Long An and Dong Thap provinces. In general, the respondents found it easy to answer the questionnaire. However, they raised some problems of communication, missing information and complexity. These were addressed accordingly in the revision of the questionnaire.

The farm survey questionnaire included five parts. Part 1 sought information on household members, income sources, assets, and rice cultivation conditions. Part 2 involved questions about inputs and costs of rice production. Part 3 was about rice outputs and revenues. Part 4 asked about the costs and revenues of other income sources while Part 5 sought information about dykes.

2.2.2 Choice Modelling

The development of the CM questionnaire was based on focus group studies. Five focus group exercises were conducted for potential respondents (4) and wetland managers (1) to ensure that inputs from both demand and supply sides of the environmental goods were received. The purposes of the focus group studies were to determine attributes relevant to respondents and wetland managers, establish appropriate cost levels and a suitable payment vehicle, and test a draft questionnaire.

The following attributes were found to be of most interest to both potential respondents and wetland managers:

Area of healthy vegetation: This refers to the area having healthy *melaleuca* forest and grassland without any invasive *mimosa pigra*

Number of Sarus cranes

Number of fish species

The number of local households affected

Different cost levels

To select a payment vehicle to display relevant cost levels, three criteria were used: good coverage, acceptability and feasibility. Good coverage means that the payment vehicle should have applicability and relevance to the studied population. Acceptability means that the payment vehicle should be widely acceptable to the respondents. Feasibility means that it is not too costly and complicated to implement. Each criterion was given a score scale of 1-10. Respondents were asked to score the proposed payment vehicles. Consensus was then reached that the electricity bill, with an average score of 7.0, would best meet these criteria (Table 1). Among other proposed payment vehicles such as water bills, income taxes, solid waste collection fees, and a newly set-up fund for wetland protection, electricity bills were believed to be superior because of their broad coverage and because payment is mandatory.

Table 1. Selecting an Appropriate Payment Vehicle Using Scoring Scales

Payment vehicles	**Coverage**	**Plausibility**	**Feasibility**	**Total average score**
Electricity bill	8.0	6.0	7.0	7.0
Newly set-up fund for wetland improvement in Tram Chim	7.0	7.0	6.5	6.8
Water bill	6.0	7.0	7.0	6.6
Income tax	5.0	6.0	7.0	6.0
Solid waste collection fee	5.0	7.0	6.0	6.0

The focus group studies showed that the maximum WTP for a hypothetical medium wetland improvement scenario lay within the range of zero to VND 100,000. The percentage of focus group respondents agreeing to pay for the proposed costs decreased as the cost levels increased.

As shown in Figure 3, most respondents agreed to pay at VND 5,000 while at VND 100,000, all refused the program. This suggests that a suitable range of cost levels is from VND 5,000 to below 100,000 (USD 0.3- 6.3).[2]

The levels of the environmental and social attributes were determined in consultation with wetland experts. The experimental design was constructed after the attributes and levels were determined. Five attributes, each with four levels including the status quo, were used in the experimental design (Table 2). Twenty-seven choice sets were selected from a full factorial of an orthogonal main effects experimental design.

[2] Exchange rate: 16,000 VND = 1 USD (December, 2006)

Two obviously implausible choices were eliminated leaving usable 25 sets. As each questionnaire contained five choice sets, it took five respondents to complete the 25 choice sets.

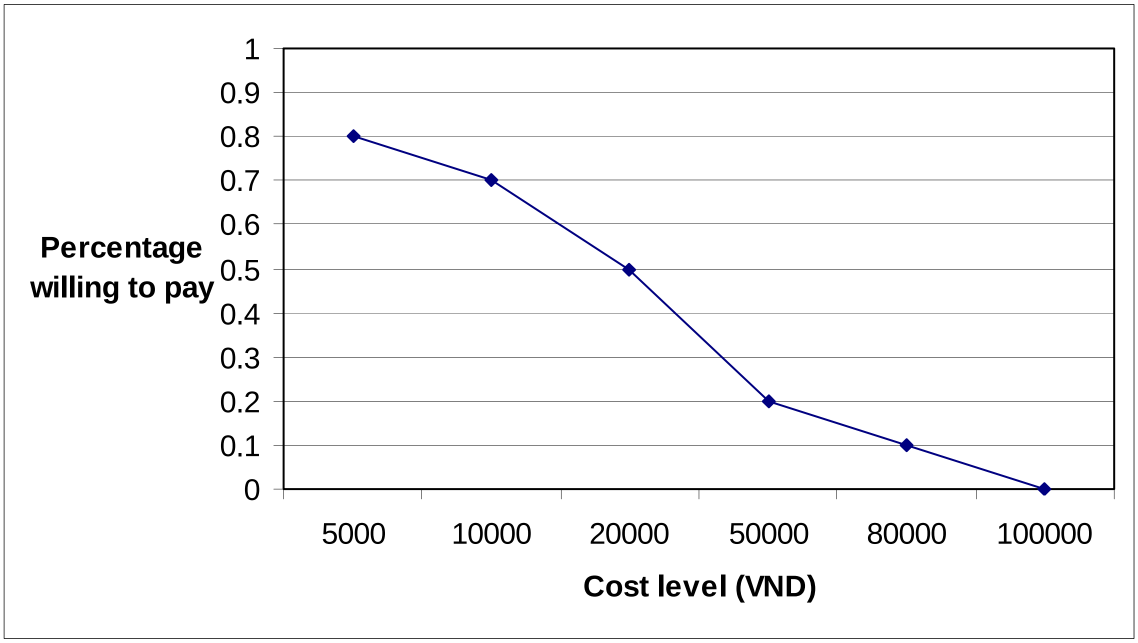


Figure 3. Cost Level and Willingness to Pay

Table 2. Attributes and Levels in the Experimental Design

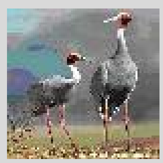
Attributes	Levels			
	Status quo	**Level 1**	**Level 2**	**Level 3**
Percentage of area having healthy vegetation	50	60	70	80
Number of Sarus cranes	150	300	450	600
Number of fish species	40	50	60	70
Number of local households worse off	0	600	900	1200
One-off change in current monthly electricity bill (thousand VND)	0	10	50	100

The questionnaire briefed respondents about the Tram Chim National Park and its biodiversity loss due to poor wetland management. It then described the proposed plan for wetland improvement and the outcomes of different management options. It continued by explaining that in order to implement the plan, governments would need to raise funds to cover the costs of dyke reconstruction, invasive species removal and control, increased hydrological and biological monitoring, and paying compensation to local farmers who would suffer from subsequent changes in flood levels. An example of a choice set is given in Table 3.

Table 3. An Example of a Choice Set

Scenario 1: Suppose options A, B and C are the ONLY ones available.

Note: The first column describes different characteristics that will change under different wetland management options. The following columns describe different outcomes of the wetland management options.

The following factors will vary under different management options	**OPTION A (status quo - no change)**	**OPTION B**	**OPTION C**
Percentage of area having healthy vegetation 	50%	60%	80%
Number of Sarus cranes visiting the wetlands per year 	150 birds	300 birds	450 birds
Number of fish species 	40 species	50 species	70 species
Number of local households worse-off 	0	900	900
One-off change in your current monthly electricity bill 	No change	Increase by VND 10,000	Increase by VND 50,000

If there were a vote (in which if the majority votes for the option you choose, then that option will be selected), you would vote for:
TICK ONE BOX ONLY

Option A ☐
Option B ☐
Option C ☐

To test the effect of cheap talk, a short and neutral cheap talk version following that of Aadland and Caplan (2006) was added. The long version of cheap talk developed by Cummings and Taylor (1999) and List (2001) was not used for two reasons. Firstly, it was too long and too complex for Vietnamese respondents. Secondly, it was not easily generalised, that is, it required either baseline information of the degree of hypothetical bias or a presumption of the degree of hypothetical bias that existed in the population for calibrating the specific wording of a cheap talk script (Aadland and Caplan 2006). The cheap talk used in this research translates as follows:

"As you prepare to answer the next few questions, please keep in mind the following three things. First, keep in mind your household budget. How much would your household be able to afford a one-off increase in the electricity bill? Second, keep in mind that there are other wetland areas in the Mekong Delta such as U Minh Thuong and Lang Sen. And third, keep in mind that in previous surveys, we have found that the options of wetland management that people say they prefer are sometimes different from the options that they would actually select when the wetland program takes place and requires real payment. For this reason, when choosing options, please imagine your household is actually paying for the options you choose."

After being pre-tested, both the CM and farm survey questionnaires were revised to enhance their clarity, comprehensiveness and accuracy. Before the survey, one more round of pre-tests for the CM and farm survey questionnaires was conducted using 50 respondents. The questionnaires were then further refined. Particular attention was paid to translation to make sure that the questionnaires were free of jargon and ambiguity.[3]

2.3 Survey Implementation

Surveys were implemented in June and July 2006. Enumerators included students from Ha Noi Economics University and Ho Chi Minh Economic University, and staff of the Department of Natural Resources and Environment (DONRE) of Tien Giang, Dong Thap and Long An provinces.

2.3.1 Production Function (PF)

Two main objectives of selecting the studied sites were representativeness and heterogeneity. Representativeness means that the studied sites need to represent rice production and dyke heights in the Plain of Reeds. Heterogeneity means that the studied sites need to have sufficient variation in data on rice production input and output under different dyke systems to produce a meaningful production function. These were achieved through consultation with local government officials, secondary data analysis and preliminary fieldwork in February 2006. The following areas were selected: Tam Nong (Tram Chim adjacent area) and Thap Muoi in Dong Thap Province, Thu Thua in Long An Province and Cai Be in Tien Giang Province. Systematic sampling was used within the selected populations. Households were the sample units whilst a member of a household was the unit of enquiry. The survey was conducted in June and July 2006. A total of 241 usable questionnaires out of 265 distributed were collected (Table 4).

[3] The questionnaires are available from the author upon request.

Table 4. Location and Sample Size for PF Survey

Location	Sample size		
	Low dykes	**High dykes**	**Total**
Tam Nong and Thap Muoi Districts, Dong Thap Province	70	61	131
Thu Thua District, Long An Province	39	24	63
Cai Be District, Tien Giang Province	16	31	47
Total	125	116	241

2.3.2 Choice Modelling

This study focused on three sub-samples of respondents. The first was drawn from the population of the MRD that was not directly affected by changes in the management of Tram Chim. This allowed for the estimation of environmental benefits enjoyed by local residents resulting from future management scenarios without the confounding effects of changes in farming incomes. Cao Lanh town in Dong Thap Province was selected as the base for this population. The target sample size was 300.

The second sub-sample was drawn from the population of urban residents of Ho Chi Minh City located adjacent to the MRD. The third sub-sample involved those who lived far away from the MRD. In this case, Vietnam's capital, Ha Noi was selected. The sub-samples in Ha Noi and Ho Chi Minh City were further split into two for testing two kinds of questionnaires. For the first sub-sample, questionnaires without cheap talk were used while in the second sub-sample, questionnaires embedded with a cheap talk script were used. The target sample size for each sub-sample was 150. The total target sample size for the CM exercise was 900 (Table 5).

The sampling frames used were maps of Cao Lanh, Ho Chi Minh City and Ha Noi. Stratified sampling was used with communes as strata. In each commune, the systematic sampling technique was used to select respondents. Households were the sample units. A member of the household over 18 years of age was the unit of inquiry.

Table 5. Location and Sample Size for CM Survey

Location	Sample size	
	Without cheap talk	**With cheap talk**
Cao Lanh		
- Farmers		150
- Non-farmers		150
Ho Chi Minh city	150	150
Ha Noi	150	150

Regarding the survey method, some authors suggest that by giving respondents more time to think about their choices, the ‘drop off-pick up’ method produces results with fewer violations of the utility theory (Cook et al. 2007). In the drop off-pick up method, enumerators deliver the questionnaires to respondents, leaving them to fill in the questionnaires by themselves and coming back later to collect the questionnaires. However, this method was not used here for several reasons. Firstly, the focus group exercises showed that asking respondents to read a complex questionnaire by themselves might be too demanding and hence respondents would be unlikely to answer the questionnaire properly, if at all. Secondly, provided that interview bias is avoided, personal interviews would enable respondents to have assistance from enumerators in understanding the issues and questions.

Thirdly, the effect of the drop off-pick up method proposed by Cook et al. (2007) may not be realized in this study. Despite being conducted in the Vietnamese context, the hypothetical goods studied by Cook et al. (2007) were cholera and typhoid vaccines, which can be considered as quasi-private goods. Respondents may have different behaviors towards those goods, as opposed to the public goods provided by the wetlands. Taking into account the relative merits of the drop off-pick up and personal interview methods (Champ 2003) in the context of a developing country where respondents, especially those with less education, do not like reading questionnaires, personal interviews with adequate time for respondents to go over the choice sets were used.

3.0 IMPACTS OF DYKES ON RICE VALUES AND HOUSEHOLD INCOMES

3.1 Households and Dykes

The farm surveys in Thap Muoi (Dong Thap Province), Thu Thua (Long An Province) and Cai Be (Tien Giang Province) were conducted across 265 households. Out of 241 usable questionnaires, 116 came from households in high dyke areas and 125 from households in low dyke areas. Socio-demographic characteristics of the sample were checked against those of the population (Vietnam General Statistics Office 2004). It was found that there was insignificant difference between the sample and the population (Table 6), therefore the sample could be said to be representative of the population.

Table 6. Socio-demographics of the Sample and Population

	Sample		**Population**	
	Mean	**Standard deviation**	**Mean**	**Standard deviation**
Age of household members	32	9.4	31.7	20
Gender	0.5	0.16	0.5	0.25
Household size (Number of persons)	3.6	1.7	4.0	1.6

Low dykes and high dykes differ in terms of physical sizes and engineering costs. In general, the low dykes in the Plain of Reeds have been built around rice farms 300-500 ha in size by a small group of households with some support from local government bodies. The average height is 1.5 m. The low dykes were built in the early 1990s for the upstream areas of Cao Lanh and from 2001-2002 in the downstream areas of Tien Giang and Long An Provinces. The average cost of building a low dyke enclosing a one-hectare area is VND 3 million. The annual maintenance cost is about VND 0.5 million per ha.

In contrast, the high dykes enclose rice farms and residential areas ranging between 500 and 1,500 ha. The dykes were built in the late 1990s and early years of the new millennium in both upstream and downstream areas. The average height is 3.5 m. The cost of building the high dykes is about VND 3.75 million per ha. The maintenance cost is about VND 0.25 million per ha per annum. While the low dykes were built by small groups of farmers in a commune with the common goal of maintaining rice production levels, the high dykes were designed and built by local governments as part of flood control strategies to protect residential areas and generate more income for a large group of farmers across several communes.

In terms of supporting farmers' incomes, the high dykes have some advantages over the low dykes. Although all households have rice cropping as their main income source, more households in high dyke areas (51%) are able to practice triple cropping compared with those in low dyke areas (18%), due to more secure flood prevention. The high dykes also appear to enable farmers to have more sources of income. The percentages of households in high dyke areas and low dyke areas having other income sources are 67% and 51% respectively. In particular, the number of high income sources such as raising livestock and having orchards is higher in the high dyke areas than in the low dyke areas. Sixty-six percent of households in the former have both livestock and orchards while only 38% of households in the latter have such income sources. This suggests that the difference in net income between the two areas is not just due to rice output differences.

3.2 Impacts of Dykes on Rice Values

A standard Cobb Douglas rice production function with the rice yield as the dependent variable was estimated.[4] The coefficients of rice inputs were similar to those found in recent studies such as Kompas (2004) and Nguyen (2006) with land as the highest, followed by material inputs of seeds, fertilizers and pesticides. However, the adjusted coefficient of determination (Adjusted R^2) of this model was found to be as high as 94%, which was questionable with this small cross-sectional data set. This might be because of the fact that many farmers recorded the rice inputs in per hectare units. To remedy this problem, per hectare units were used for rice production output and inputs. The adjusted R^2 of this model then became 0.41, which was more plausible. Therefore, in subsequent models, per hectare units were used. The definitions of the variables are given in Table 7. In these models, heteroscedasticity was tested for and corrected using the weighted least square method of Breusch-Pagan (Wooldridge 2000). Also, no multicollinearity in the independent variables was found, using the correlation matrix method to check for any correlations that were more than 70%.

[4] As mentioned in Section 2.1.1, the Cobb-Douglas production function has been preferred to other functional forms for rice production in the MRD in recent studies.

Table 7. Description of Variables in Rice Production Function

Variable	Definition	Unit
Rice	Total rice yield a year per hectare per year	tonnes/hectare/year
Land	Area of cultivated land	hectare
Capital	The operating duration of machines at all stages of rice production	hours/hectare/year
Labor	The number of man-hours for rice production	hours/hectare/year
Fertilizer	Total amount of fertilizer used	kg/hectare/year
Seed	Total amount of seed used	kg/hectare/year
Pesticide	Total amount of pesticides used per year	equivalent unit of 100ml/hectare/year
Herbicide	Total amount of herbicides used per year	equivalent unit of 100ml/hectare/year
Soil	Soil quality	(1 = fertile soil, 0 = other soils)
Plot	Number of plots, representing farm fragmentation	unit
Disaster	Disasters that happened during the year, including pests, droughts and floods	1= yes, 0 = no
Irrigation	Distance to irrigation sources	meter
Experience	The number of years of rice cultivation	years
Training	Have attended training on rice production	1 = yes, 0 = no
Dyke	Dyke height	1 = high dyke and 0 = low dyke
Flood	Duration of floods a year	day/year
Location	Location of the farms (used for capturing all other factors that might have impact on rice productivity)	1 = upstream, 0 = downstream of the Mekong River

Several models of the rice production function were estimated. Firstly, a model without the dyke variable was estimated (Table 8). Rice inputs, labor, fertilizer, seed and pesticide were found to be statistically significant with *a priori* expected signs. Capital and herbicide were not statistically significant. This might be because of the conversion from monetary to physical units in some farms where physical units were not available. The goodness of fit of the model was good for a cross-sectional data set with the adjusted R^2 of 0.41. Regarding environmental factors, the soil, location and disaster parameters were statistically significant at 5% while farm fragmentation (see Plot) and irrigation conditions were not. Farming experience increased rice productivity while training on rice production did not have any effect.

Secondly, separate models were estimated to investigate rice production in low and high dyke areas. It was found that rice production in the two dyke areas were different. In high dyke areas, labor, seed, and disaster had effects on rice productivity while in low dyke areas, the significant factors included fertilizer, pesticide, soil, experience and location (Table 9). The average rice yields and variability also differed in two areas (Table 10). The mean and standard deviation for rice productivity in 2005 (when this survey was conducted) in the high dykes were 15.7 and 3.04 while those in the low dykes were 13.4 and 2.71 respectively. However, these figures for an eight-year period from 1998 to 2005 in the high dyke areas were 15.5 and 2.5, as opposed to 12.1 and 3.1 in the low dyke areas respectively. This suggests that in the long term, high dyke areas generate higher annual rice productivity with less risk than low dyke areas.

Thirdly, a model with pooled data including the dyke variable was estimated. In this model, among the rice input variables, only labor had an effect on rice productivity that was significant at the 1% level. Soil, disaster, experience and location were statistically significant at the 5% level with *a priori* expected signs. Using the method proposed by Halvorsen and Palmquist (1980) to interpret the effects of dykes, high dykes were found to increase rice productivity by about 4%, other things being held constant, significant at the 10% level (Table 11).[5]

In a subsequent model, the dyke variable was replaced by the flood variable to analyze the impacts of flood duration on rice productivity. It was found that flooding prolonged by one day reduced rice productivity by 0.06%, significant at the 5% level (Table 12).[6]

To analyze distributional impacts of dykes on rice productivity, a model of the location variable interacting with all other independent variables was estimated. The null hypothesis was that by eliminating flooding, which is usually more severe in upstream than downstream areas, high dykes would increase rice productivity more in the upstream areas than in downstream areas. However, the interaction between dyke and location was found to be insignificant (Table 13). This indicates that there is no significant impact of dyke height on rice productivity in either upstream or downstream areas. Therefore, the null hypothesis could not be accepted.

[5] The interactions of the variable 'dyke' with other input variables were also estimated in a separate model but were found insignificant at 5%. This suggests that dykes do not have an effect on the marginal products of inputs.

[6] The variable 'flood duration' may reflect some of the effects of dykes. The dykes may have other impacts that require more complex models to analyze. The use of the flood duration variable in this study was aimed at facilitating the calculation of the impacts of prolonged flood duration due to dyke conversion.

Table 8. Rice Production Function without Dyke Variable

Variable	Coefficient (Standard error)
Constant	1.02** (0.22)
Capital	0.016 (0.014)
Labor	0.062*** (0.02)
Fertilizer	0.062** (0.03)
Seed	0.066* (0.038)
Pesticide	0.046** (0.02)
Herbicide	-0.008 (0.026)
Soil	0.083** (0.03)
Plot	-0.007 (0.005)
Disaster	-0.04** (0.02)
Irrigation	-0.0008 (0.0007)
Experience	0.0026*** (0.0009)
Training	-0.009 (0.02)
Location	0.14*** (0.04)
Statistic summary	
R square	0.44
Adjusted R-square	0.41
Std. error of regression	0.15
Included observations	227

Note: *** denotes statistical significance at 1% level, ** denotes statistical significance at 5% level and * denotes significance at 10% level.

Table 9. Rice Production in High Dyke and Low Dyke Areas

Variable	High dykes Coefficient (Standard error)	Low dykes Coefficient (Standard error)
Constant	1.08*** (0.48)	1.53*** (0.31)
Labor	0.07** (0.03)	-0.007 (0.02)
Capital	0.019 (0.02)	-0.018 (0.02)
Fertilizer	-0.007 (0.06)	0.08** (0.03)
Seed	0.15** (0.06)	0.02 (0.05)
Pesticide	0.016 (0.03)	0.07*** (0.02)
Herbicide	0.03 (0.04)	-0.04 (0.02)
Soil	0.02 (0.06)	0.15*** (0.03)
Plot	-0.01 (0.008)	-0.018 (0.01)
Disaster	-0.06** (0.03)	-0.01 (0.03)
Irrigation	-0.0007 (0.0008)	0.001 (0.001)
Experience	0.0007 (0.001)	0.004*** (0.001)
Training	0.007 (0.03)	-0.03 (0.04)
Location	0.05 (0.08)	0.22*** (0.05)
Statistic summary		
R-square	0.30	0.55
Adjusted R-square	0.20	0.49
Std. error of regression	0.18	0.17
Included observations	108	119

Note: *** denotes statistical significance at 1% level, ** denotes statistical significance at 5% level and * denotes significance at 10% level.

Table 10. Mean Rice Yield and Variability of Yield in High Dyke and Low Dyke Areas

	High dyke area		**Low dyke area**	
	Mean yield	**Standard deviation**	**Mean yield**	**Standard deviation**
Year 2005	15.7	3.04	13.4	2.71
1998- 2005	15.5	2.5	12.1	3.1

Table 11. Rice Production Function with Dyke Variable

Variable	**Coefficient (Standard error)**
Constant	1.32*** (0.20)
Labor	0.06*** (0.02)
Capital	0.009 (0.015)
Fertilizer	0.02 (0.02)
Seed	0.05* (0.03)
Pesticide	0.03* (0.01)
Herbicide	0.007 (0.02)
Dyke	0.04* (0.02)
Soil	0.09*** (0.02)
Plot	-0.008 (0.008)
Disaster	-0.04** (0.02)
Irrigation	-0.0008 (0.0007)
Experience	0.003*** (0.0008)
Training	-0.04 (0.03)
Location	0.16*** (0.04)
Statistic summary	
R-square	0.44
Adjusted R-square	0.40
Std. error of regression	0.18
Included observations	227

Note: *** denotes statistical significance at 1% level, ** denotes statistical significance at 5% level and * denotes significance at 10% level.

Table 12. Impacts of Flood Duration on Rice Productivity

Variable	Coefficient (Standard error)
Constant	1.37*** (0.24)
Labor	0.06*** (0.01)
Capital	0.003 (0.014)
Fertilizer	0.03 (0.02)
Seed	0.04 (0.03)
Pesticide	0.028 (0.018)
Herbicide	0.019 (0.02)
Flood	-0.0006* (0.0003)
Soil	0.12*** (0.02)
Plot	-0.009 (0.008)
Disaster	-0.05*** (0.01)
Irrigation	-0.0008 (0.0007)
Experience	0.003*** (0.0008)
Training	-0.04 (0.02)
Location	0.16*** (0.04)
Statistic summary	
R-square	0.45
Adjusted R-square	0.42
Std error of regression	0.18
Included observations	227

Note: *** denotes statistical significance at 1% level, ** denotes statistical significance at 5% level and * denotes significance at 10% level.

Table 13. Impacts of Dykes on Rice Production in Different Locations: Upstream vs. Downstream

Variable	Coefficient (Standard error)	Variable	Coefficient (Standard error)
Constant	069. (0.43)	Location*labor	-0.02 (0.04)
Labor	0.02 (0.04)	Location*capital	-0.03 (0.03)
Capital	0.016 (0.029)	Location*fertilizer	0.08 (0.07)
Fertilizer	0.009 (0.06)	Location*seed	-0.02* (0.09)
Seed	0.22** (0.08)	Location*pesticide	-0.06* (0.03)
Pesticide	0.051* (0.03)	Location*herbicide	-0.006 (0.04)
Herbicide	-0.02 (0.04)	Location*dyke	-0.04 (0.06)
Dyke	0.11* (0.05)	Location*soil	-0.12* (0.06)
Soil	0.16*** (0.06)	Location*plot	0.001 (0.02)
Plot	-0.008 (0.02)	Location*disaster	0.22*** (0.08)
Disaster	-0.22*** (0.08)	Location*irrigation	-0.001 (0.001)
Irrigation	0.72E-03 (0.001)	Location*experience	-0.004** (0.001)
Experience	0.005*** (0.001)	Location*training	0.02 (0.06)
Training	0.003 (0.05)		
Location	0.86* (0.48)		
Statistic summary			
	R-square	0.45	
	Adjusted R-square	0.42	
	Std. error of regression	0.18	
	Included observations	227	

Note: *** denotes statistical significance at 1% level, ** denotes statistical significance at 5% level and * denotes significance at 10% level.

However, two precautions need to be taken when interpreting these results. First, this study is based on cross-sectional data and hence only provides information at the time of the study.[7] Second, this study focused on the impacts of dykes on rice productivity only. High dykes also result in other benefits including additional income sources, mitigated infrastructure damage, reduced flood-related accidents and daily life convenience. Further research is needed to observe more comprehensively and accurately the impact of high dykes on rice productivity and other values.

[7] The flood in 2005 was characterised as a medium flooding event (Mekong River Commission 2005). Therefore, the findings of this study provide an average range of the impacts of flooding and the proposed dyke conversion. Time series data including data on extreme flooding events would provide a more comprehensive analysis of the impacts of the proposed conversion.

3.3 Impacts of Dykes on Other Wetland Market Values

To investigate the impacts of dykes on other wetland market values, a model of the effect of high dykes on total income should be studied. However, the data on incomes from sources other than rice was insufficient to construct such a mode here. Therefore, an analysis of the relationship between the numbers of income sources was used instead. A simple linear regression showed that the relationship between the number of other income sources and high dykes was positive with a coefficient of 0.38, statistically significant at the 1% level. This suggests that by having high dykes, farmers can have more income sources. This explains why farmers with high dykes can own livestock and orchards, which generate more income than rice. According to Hoi (2005), each household in high dyke areas can earn about VND 15 million more per year from raising cows and pigs than those in low dyke areas.

High dykes also have other market and non-market values. The market values of high dykes can be estimated using the avoided costs of flooding. These include reduced damage to houses and infrastructure and reduced costs of evacuation. The costs of flooding for the whole MRD in 2001 were estimated at about VND 4,000 billion or about USD 300 million (Minh 2001). The non-market values of high dykes include reduced flood-related accidents and convenience in daily life. Further research on the impacts of high dykes on market and non-market values is needed to provide more comprehensive information on the benefits and costs of high dykes.

4.0 WILLINGNESS TO PAY FOR WETLAND IMPROVEMENT

4.1 Respondents' Socio-economic Characteristics

The numbers of useable CM questionnaires in the Ha Noi, Ho Chi Minh and Cao Lanh sub-samples were 370, 289 and 258 respectively. In Ha Noi, the sizes of the spilt samples for cheap talk and non-cheap talk were 186 and 184 while those in Ho Chi Minh City were 145 and 144 respectively. Cao Lanh had the highest response rate (78.6%), followed by Ho Chi Minh City (62.7%) and Ha Noi (52.5%) (Table 14). This also represents the order of distance to Tram Chim National Park: Cao Lanh (40 km), Ho Chi Minh City (250 km) and Ha Noi (2,000km).

Table 14. Response Rate

Location	Number of people approached	Number of respondents	Response rate (%)
Ha Noi	714	375	52.5
Ho Chi Minh	467	293	62.7
Cao Lanh	388	305	78.6
Total	1569	973	62

To examine the representativeness of the sub-samples, a comparison between the socio-demographic characteristics of the samples and the populations was conducted. It was found that the samples were biased toward younger, better educated, wealthier males in the three locations (Table 15). This might be due to the fact that the surveys targeted urban residents that had younger, more educated and wealthier populations in which most household heads were men. Also, it may be because people with a high education are more likely to be willing to participate in interviews, as noted by the enumerators.

Table 15. Socio-demographics of the Respondents

Socio-economic characteristics	**Ha Noi**		**Ho Chi Minh City**		**Cao Lanh**	
	Sample mean	**Population mean**	**Sample mean**	**Population mean**	**Sample mean**	**Population mean**
Age (>= 18 years)	32.7	42	37.1	40.4	35.9	40.1
Education (% > year 12)	55	21.3	43	11.5	16	4.3
Monthly income per household (million VND)	4.8	3.5	6.7	5.5	2.6	2.3
Sex (% male)	51	50	56	53	54	48

Respondents' views on the importance of the public sector and environmental issues were homogeneous in all three locations. Environment was ranked as the second most important issue, preceded by education. Water pollution was ranked the most important environmental issue, followed by air pollution. Wetland biodiversity conservation was ranked as least important in all three locations.

4.2 Model Specifications

4.2.1 Multinomial Logit

The LIMDEP software package was used to run MNL models of the choice data. Two models were estimated for each location. Model 1 was a basic model showing the importance of the attribute variables in explaining respondents' choices across three different options in a choice set: status quo (no change) and two alternatives of change. This model involves the attribute variables and an alternative specific constant (ASC) only. Model 2 includes socio-economic and attitudinal characteristics interacting with the ASC and some selected attribute variables. In this case, the attribute 'cost' was interacted with 'age', 'gender', 'income' and 'education'. Definitions of the variables used in these models are presented in Table 16.

Models 1 and 2 were estimated twice: the first time including all respondents and the second time excluding the scenario-rejecting respondents. Scenario-rejecting respondents were those who met one of the following criteria:

Did not believe in the feasibility of or did not support the one-off increase in electricity bills

Did not believe in the scenarios presented

Did not believe that the raised funding will be used for environmental purposes

Believed that it is the government that should pay for wetland improvement, not citizens

Selected the options randomly without considering the attributes and levels[8]

The scenario-rejecting respondents accounted for 32% of the total respondents. The models without scenario-rejecting respondents were found to have higher pseudo-R^2 than the inclusive models, insignificant ASCs and *a priori* expected signs of the significant variables (Table 17) – this suggests that the models without scenario-rejecting respondents provided more reliable results than the inclusive models. Therefore, the models excluding scenario-rejecting respondents were used for further analysis. Insignificant socio-economic variables were not included in subsequent model estimations.

[8] This was detected by asking a follow-up question "How did you select the options presented?". About three per cent of the respondents reported that they had selected the options randomly.

Table 16. Definitions of Variables

Variables	Definitions
Attribute variables	
ASC	Alternative specific constant, taking the value of 0 for the status quo (no change) and 1 for the alternatives
Vegetation	% of Tram Chim National Park covered by healthy *melaleuca* and grass without the invasive *mimosa pigra*
Sarus cranes	The number of Sarus cranes, an endangered bird species, visiting Tram Chim
Fish	The number of fish species in Tram Chim
Farmers	The number of households that will be affected by the proposed change in dyke and wetland management of Tram Chim
Cost	Cost to respondents in the form of a one-off increase in current electricity bill
Non-attribute variables	
Age	Age of respondents (in years)
Gender	Male: 1, Female: 0
Education	Education level of respondents, taking the value of 1 for tertiary and above, and 0 for otherwise
Income	Monthly income of the household (thousand VND) in cardinal forms: 500, 2000, 4000, 6000, 8000, 10000, 12000, and 13000
Knowledge	Respondents have heard or read about Tram Chim, taking the value of 1 for YES and 0 for NO
Visit	Previous visit to Tram Chim, taking the value of 1 for YES and 0 for NO
Option	Possible future visits to Tram Chim, taking the value of 1 for YES and 0 for otherwise
Bequest	That wetland improvement will benefit future generations, taking the value of 1 for YES and 0 for otherwise
Pro-wetland	Supports wetland conservation, taking the value of 1 for YES and 0 for otherwise
Concern	Concern about wetland biodiversity degradation, taking the value of 1 for YES and 0 for otherwise[9]
Cheap talk	Received the ‘cheap talk’ script in the questionnaire, taking the value of 1 for YES and 0 for NO

[9] Variables ‘pro-wetland’ and ‘concern’ can be considered as endogenous variables. They were found insignificant at 5% level in the pooled data model estimation and hence were not included in subsequent models.

Table 17. Results of Multinomial Logit Models for Pooled Data from Three Locations

Variables	**All respondents included**		**Protest zero and scenario rejecting respondents excluded**	
	Model 1	**Model 2**	**Model 1**	**Model 2**
ASC	0.925*** (0.148)	-0.446* (0.248)	1.337*** (0.177)	0.182 (0.347)
Vegetation	0.91E-02*** (0.9E-02)	0.0112*** (0.214E-02)	0.117E-01*** (0.023E-01)	0.014*** (0.26E-02)
Sarus cranes	0.118E-02*** (0.19E-03)	0.001*** (0.2E-04)	0.014E-01*** (0. 2E-03)	0.14E-02*** (0.2E-03)
Fish	0.35E-02 (0.28E-02)	0.32E-02 (0.31E-02)	0.42E-02 (0.34E-02)	0.003 (0.004)
Farmers	-0.12E-02*** (0.9E-04)	-0.124E-02*** (0.1E-03)	-0.13*** (0.1E-03)	-0.133E-02*** (0.12E-03)
Cost	-0.015*** (0.7E-03)	-0.015E-03*** (0. 7E-06)	-0.0165*** (0. 8E-03)	-0.166E-04*** (0.9E-06)
ASC*age		0.0114*** (0.32E-02)		0.019*** (0.004)
ASC*gender		0.025 (0.077)		0.024 (0.103)
ASC*education		0.089*** (0.081)		1.226*** (0.111)
ASC*income		0.54E-03*** (0. 1E-04)		0.05E-02*** (0.02E-03)
ASC*knowledge		0.629*** (0.084)		0.44*** (0.11)
ASC*visit		-0.478*** (0.129)		-0.63*** (0.15)
ASC*option		0.455*** (0.087)		0.43*** (0.11)
ASC*bequest		0.925*** (0.08)		0.533*** (0.111)
ASC*pro-wetland		-0.369*** (0.077)		-0.0879 (0.104)
ASC*concern		0.17 (0.13)		-0.061 (0.209)
ASC*cheap talk		-0.4268*** (0.817E-01)		-0.558*** (0.117)
Education*cost		-0.228E-02 (0.15E-02)		0.373E-02** (0.176E-02)
Income*cost		0.55E-07 (0.228E-06)		0.15E-06 (0.27E-06)
Age*cost		0.138E-03** (0.58E-04)		0.447E-04 (0.714E-04)
Gender*cost		0.656E-03 (0.148E-02)		0.108E-03 (0.178E-02)
Statistic summary				
Log-likelihood	-4818.714	-3712.726	-3191.307	-2449.007
Pseudo-R2	0.07	0.149	0.09	0.158
Observations	4755	4555	3225	3225

Notes: Standard deviations are in parenthesis. *** denotes statistical significance at 1% level, ** denotes statistical significance at 5% level and * denotes significance at 10% level.

4.2.2 Random Parameter Logit

To relax the IID (independent and identical distribution) assumption and further investigate heterogeneity in the respondents' preferences, random parameter logit (RPL) models were used. In RPL models, preference parameters are assumed to have statistical distributions arising from potentially different parameters for each individual (Revelt and Train 1998). The steps suggested by Hensher et al. (2005) were followed to estimate the RPL. First, all attributes except for the cost attribute, were estimated as random parameters. Second, the random parameters having distributions with insignificant standard deviations were re-estimated as non-random parameters. The RPL model with 100 random draws and normal distributions for random parameters showed that the respondents had heterogeneous preferences for vegetation and birds, significant at the 1% level (Table 18).

Table 18. Results of MNL and RPL Models for Pooled Data from Three Locations

Variables	**MNL**	**RPL**	
		Mean	**SD**
ASC	-0.323E-01 (0.289)	0.189 (0.346)	
Vegetation	0.139E-01*** (0.257E-02)	0.149E-01*** (0.299E-02)	0.358E-01*** (0.719E-02)
Sarus Cranes	0.137E-02*** (0.242E-03)	0.149E-02*** (0.273E-03)	0.201E-02** (0.976E-03)
Fish	0.305E-02 (0.366E-02)	0.449E-02 (0.409E-02)	
Farmers	-0.133E-02*** (0.124E-03)	0.159E-02*** (0.159E-03)	
Cost	-0.146E-04 *** (0.126E-02)	0.172E-04*** (0.165E-05)	
ASC*age	0.187E-01*** (0.43E-02)	0.218E-01*** (0.541E-02)	
ASC*education	1.339*** (0.138)	1.532*** (0.172)	
ASC*income	0.544E-04*** (0.165E-04)	0.699E-04*** (0.208E-04)	
ASC*knowledge	0.446*** (0.11)	0.549*** (0.139)	
ASC*visit	-0.837*** (0.148)	-1.052*** (0.2)	
ASC*option	0.386*** (0.111)	0.467*** (0.138)	
ASC*bequest	0.491*** (0.109)	0.627*** (0.143)	
ASC*cheap talk	-0.605*** (0.115)	-0.747*** (0.148)	
Education*cost	0.373E-02** (0.176E-02)	-0.282E-02 (-0.197E-02)	
Statistic summary			
Log-likelihood	-2459.043	-2448.107	
Pseudo-R2	0.15	0.17	
Observations	3225	3225	

Notes: Standard deviations are in parenthesis. *** denotes statistical significance at 1% level, ** denotes statistical significance at 5% level and * denotes significance at 10% level.

Both the multinomial logit (MNL) and RPL models showed that respondents preferred more healthy vegetation, more birds, fewer farmers affected and less cost. The number of fish species was insignificant to respondents. Older respondents with bigger incomes and higher education chose wetland improvement options more frequently than younger respondents with smaller incomes and lower education. Respondents who had some previous knowledge about Tram Chim, and thought that they would visit Tram Chim in the future and that future generations would benefit from Tram Chim wetland improvement chose improvement options more frequently. On the other hand, respondents chose the status quo option more often if they had visited Tram Chim before. The MNL analysis revealed that the respondents with higher education were more concerned about the increase in the electricity bill. However, this was not observed with the RPL model.

While the RPL model was more complex, both models produced similar results in terms of the magnitudes, signs and significance levels of the coefficients, except for education interacting with the cost variable (Table 18). In addition, the pseudo R^2 of the RPL model was not much higher than that of the MNL model. Moreover, the Poe et al. (2005) test showed that there was an insignificant difference between implicit price estimates produced by the MNL and RPL models (Table 19). Therefore, for simplicity, the MNL was used for further analysis.

Table 19. Test of Differences in Implicit Prices between the MNL and RPL Models

Variables	**Total Implicit Prices MNL (VND)**	**Total Implicit Prices RPL (VND)**	**Proportion of $IP_{MNL} - IP_{RPL} > 0$**
Vegetation	920 (607 ~ 1239)	868 (550~1190)	0.4
Sarus cranes	90 (58 ~ 119)	84 (56~111)	0.39
Farmers	-87 (-102 ~ -73)	-83 (-98~ -68)	0.61

Note: Confidence intervals at 95%, calculated using Krinsky and Robb (1986) bootstrapping procedure, are given in brackets.

The MNL model (Table 19) showed that across the whole sample, respondents were, on average, willing to pay VND 920 (USD 0.06 for a one per cent increase in healthy vegetation and VND 900 (USD 0.06) for an additional ten Sarus cranes. However, the economic tradeoff (for the respondents) was VND 870 (USD 0.06) for every ten local households made worse-off by the proposed dyke and wetland management change.

4.3 Effects of Distance to Tram Chim

To analyze the effects of distance to Tram Chim on respondent choice, the models of respondents receiving the cheap talk questionnaire in Ha Noi, Ho Chi Minh City and Cao Lanh were estimated (Table 20). All signs of the explanatory coefficients were as expected. Respondents in the three sub-samples preferred having fewer farmers affected and less cost with coefficients for these attributes significant at the 1% level. The respondents in Ha Noi and Ho Chi Minh City showed a preference for more Sarus cranes whilst the respondents in Cao Lanh preferred more healthy vegetation. The number of fish species was irrelevant to respondents' choices in all three locations.

Table 20. Results of MNL Models in Three Locations

Variable	Ha Noi	Ho Chi Minh	Cao Lanh
ASC	-0.653 (0.536)	-0.869 (0.755)	-0.372 (0.634)
Vegetation	0.145E-01*** (0.493E-02)	0.915E-02 (0.69E-02)	0.238E-01*** (0.666E-02)
Sarus cranes	0.182E-02*** (0.457E-03)	0.122E-02* (0.671E-03)	0.827E-03 (0.622E-03)
Fish	0.199E-02 (0.695E-02)	0.665E-02 (0.973E-02)	0.983E-02 (0.946E-02)
Farmers	-0.138E-02*** (0.234E-02)	-0.884E-03*** (0.333E-03)	-0.252E-02*** (0.335E-03)
Cost	-0.868E-05*** (0.25E-05)	-0.16E-01*** (0.338E-02)	-0.195E-01*** (0.283E-02)
ASC*age	0.287E-01*** (0.891E-02)	0.432E-01*** (0.165E-01)	0.161E-01* (0.852E-02)
ASC*gender	-0.396* (0.223)	1.023*** (0.299)	0.735E-01 (0.205)
ASC*education	2.723*** (0.321)	0.687E-01 (0.385)	0.964*** (0.314)
ASC*income	0.84*** (0.284)	-0.523 (0.32)	1.125*** (0.293)
ASC*knowledge	0.537** (0.227)	0.501 (0.341)	0.174 (0.281)
ASC*visit	-0.966E-01 (0.708)	-0.352 (0.603)	-0.337 (0.227)
ASC*option	-0.409E-01 (0.249)	0.803 (0.356)	0.439*** (0.217)
ASC*bequest	-0.143 (0.26)	0.693 (0.33)	1.043*** (0.228)
Cost*education	-0.572E-02* (0.331E-02)	-1.104E-01** (0.493E-02)	-0.623E-02 (0.491E-02)
Statistic summary			
Log likelihood Pseudo-R2 Observations	-635.1893 0.17 740	-327.12 0.18 385	-462.7466 0.19 540

Note: Standard deviations are in parenthesis. *** denotes statistical significance at 1% level, ** denotes statistical significance at 5% level and * denotes significance at 10% level.

Female respondents in Ha Noi chose change options more frequently[10] while female respondents in Ho Chi Minh City preferred the current situation. In Ha Noi and Cao Lanh, the respondents with higher education and incomes chose non-status quo options more frequently while this was not observed in Ho Chi Minh City. Knowledge about Tram Chim was significant in determining respondents' preferences only in the Ha Noi sub-sample, the most distant sample from Tram Chim. In Ha Noi and Ho Chi Minh

[10] This became insignificant when the model was re-estimated with significant variables only.

City, respondents with higher education were more concerned about the increase in their electricity bills.

Except for the number of fish species, which always showed an insignificant coefficient, implicit prices of the attributes differed in three sub-samples (Table 20). The Poe et al. (2005) test was used to compare the implicit prices in three locations. Ha Noi and Cao Lanh respondents were willing to pay a similar amount of about VND 1,100 (USD 0.08) for an increase of one per cent in healthy vegetation in Tram Chim while respondents in Ho Chi Minh were indifferent to vegetation change. Respondents in Ha Noi had a marginal willingness to pay (WTP) about VND 1,210 (USD 0.07) for an increase of ten Sarus cranes while the marginal values of respondents in Ho Chi Minh and Cao Lanh for the same option were not significant. The WTP for reducing local households affected by ten was about VND 1,160 (USD 0.08) in Ha Noi and Cao Lanh, and VND 580 (USD 0.04) in Ho Chi Minh City.

These findings suggest that there is no distance decay effect on the implicit prices of the variables. On the other hand, the marginal WTP for Sarus cranes showed an inverse trend, with respondents in further sites having positive values while those in closer locations showing zero values. One reason for this might be respondents' concern about the possible spread of bird flu by wild birds, as some respondents in Cao Lanh raised this issue.

To further investigate the distance decay effect, the compensating surplus for a specific management change scenario was calculated for each sub-sample. The status quo and the change scenario in three years' time predicted by wetland managers were:

Status quo scenario: 50% healthy vegetation, 150 Sarus cranes, 40 fish species, and no farmers affected.

Change scenario: 70% healthy vegetation, 600 Sarus cranes, 40 fish species, and 300 households to be relocated.

The indirect utility of the average respondent was calculated using the coefficients of the significant variables. The ASCs were not included in welfare measures because they were insignificant in the model estimations. Table 21 shows the inverse distance decay function. The average respondent in Ha Noi had a mean WTP of VND 39,327 (USD 2.5) while respondents in Ho Chi Minh City and Cao Lanh were not willing to pay for the program.[11] This is because for respondents in Ho Chi Minh City and Cao Lanh, the marginal values for the wetland attributes were not large enough to compensate for the marginal values of reducing the number of local farmers negatively affected in the latter areas. Hence, it can be surmised that the inverse distance decay function arose because although the local people in Ho Chi Minh City and Cao Lanh desire the benefits of wetland improvement, they also know that they will be most affected by the costs of such a program. The costs include not only increased electricity bills but also potential increased prices of rice and other agricultural products due to farmers' losses after the dyke conversion. Because Ho Chi Minh City and Cao Lanh are closer to the affected areas than Hanoi, the respondents in these two areas would bear these costs more directly.

[11] The confidence intervals at 95% of WTP of Ho Chi Minh and Cao Lanh respondents included zero, indicating that the WTP of the two sub-samples were not significantly different from zero.

The inclusion of these costs in respondents' minds when making their choice would have reduced the WTP of local respondents.

Table 21. Implicit Prices and Compensating Surplus in Three Locations

	Ha Noi	**Ho Chi Minh**	**Cao Lanh**
Implicit prices (VND) of:			
Vegetation	930 (218 ~ 1646)	0	1290 (723 ~ 1898)
Sarus cranes	121 (57 ~ 185)	71 (-16 ~ 150)	0
Farmers	-114 (-146 ~ -81)	-58 (-97 ~ -26)	-119 (-146 ~ -93)
Compensation surplus (VND)	39,327 (8,613 ~ 70,195)	14,498 (50,640 ~ -23,275)	-10,303 (-21,635 ~ 2,336)
Distance from Tram Chim	40km	250km	2,000km

Note: Confidence intervals at 95%, calculated using Krinsky and Robb (1986) bootstrapping procedure, are given in brackets.

In general, respondents living outside the MRD are willing to pay for improved wetland biodiversity conservation resulting from changed dyke management of the Tram Chim National Park. However, they were concerned about the impacts of dyke management on the local farmers. Their estimated values for wetland conservation initiatives, therefore, depend not only on wetland biodiversity improvement but also on the number of farmer households affected. This is consistent with the findings of Whitten and Bennett (2005) and van Bueren and Bennett (2004) in the Australian context.

4.4 Effects of Cheap Talk

A cheap talk test was conducted using a dummy variable 'cheaptalk' for the Ha Noi and Ho Chi Minh City sub-samples. It was found that in Ha Noi, respondents receiving the cheap talk script version of the questionnaire chose status quo options more frequently while in Ho Chi Minh City, this effect was not observed (Table 22). This suggests that cheap talk reduced the WTP of Ha Noi respondents who lived far away from Tram Chim. List (2001) and Lusk (2003) found similar results for a market good: cheap talk did not have an effect on those who were more familiar with the good.

To investigate the effects of cheap talk in the Ha Noi sub-sample, the Swait and Louviere (1993) test was conducted for two sub-samples: cheap talk and non-cheap talk. This test has two stages. The first stage involves testing the null hypothesis that the parameters of the two sub-samples are equal while permitting the scale factors to vary, using a likelihood ratio (LR) test. The LR statistics for this hypothesis is calculated by the equation:

$$2[L_{joint} – (L_{cheaptalk} + L_{no\text{-}cheaptalk})]$$

where

L_{joint} is the log likelihood value corresponding to the estimation of the relative scale factor in the combined data set, and

$L_{cheaptalk}$ and $L_{no\text{-}cheaptalk}$ are the log likelihood values corresponding to the cheap talk and no-cheap talk models, respectively.

The second stage involves testing the null hypothesis of equal scale parameters. The LR statistic for this hypothesis is -2*(LL-L_{joint}), where LL is the log likelihood value for the combined data set in which the scale factors of the two samples are assumed to be equal, and L_{joint} is defined as above.

Table 22. Effects of Cheap Talk in Ha Noi and Ho Chi Minh City

Variable	Ha Noi	Ho Chi Minh City
ASC	-0.103 (0.422)	0.618 (0.532)
Vegetation	0.118E-01*** (0.35E-02)	0.029E*** (0.485E-02)
Sarus cranes	0.171E-02*** (0.327E-03)	0.11E-02** (0.464E-03)
Fish	0.207E-02 (0.498)	0.192E-03 (0.689E-02)
Farmers	-0.118E-02*** (0.166E-03)	-0.103E-02*** (0.233E-03)
Cost	-0.119E-04*** (0.118E-05)	-0.172E-04*** (0.237E-05)
ASC*knowledge	0.477*** (0.16)	0.873*** (0.199)
ASC*visit	0.567 (0.646)	0.581 (0.548)
ASC*age	0.267E-01*** (0.683E-02)	0.174E-01** (0.868E-02)
ASC*gender	-0.370** (0.161)	0.670*** (0.198)
ASC*income	0.519E-04** (0.279E-04)	-0.221E-04 (0.254)
ASC*education	2.389*** (0.223)	0.108 (0.26)
Education*cost	-0.414E-02* (0.24E-02)	-0.507E-02 (0.341E-02)
ASC*cheaptalk	-0.662*** (0.164)	0.442E-01 (0.197)
Statistic summary		
Log likelihood	-1223.444	-674.013
Pseudo-R2	0.16	0.14
Observations	1430	765

Note: Standard deviations are in parenthesis. *** denotes statistical significance at 1% level, ** denotes statistical significance at 5% level and * denotes significance at 10% level.

The LR test results in Table 23 show that the hypothesis of equal preference parameters is rejected at the 1% level. The $\mu_{no\text{-}cheaptalk}$ was 1.27, implying that the no-cheaptalk model had a lower error variance than the cheap talk model. However, this relative scale factor was insignificantly different from unity at 5% (with the p-value of the LR test for equal scale factors at 0.08). These results suggest that cheap talk has an effect on preference parameters but no effect on scale parameters. Calrsson et al. (2004) found similar results when testing the effects of cheap talk on Swedish respondents' WTP for food.

Table 23. Effects of Cheap Talk on Preference and Scale Parameters in the Ha Noi Sub-sample

Variable	No cheap talk	Cheap talk	Joint model
ASC	0.508 (0.682)	-1.09** (0.535)	-0.291 (0.393)
Vegetation	0.01*** (0.5E-02)	0.143E-01*** (0.494E-02)	0.841E-02*** (0.282E-02)
Sarus cranes	0.16E-02*** (0.474E-03)	0.189E-02*** (0.458E-03)	0.126E-02*** (0.263E-03)
Fish	-0.693E-03 (0.714E-02)	0.004E-02 (0.701E-02)	0.247E-02 (0.406E-02)
Farmers	-0.101E-02*** (0.239E-03)	-0.137*** (0.234E-03)	-0.108E-02*** (0.132E-03)
Cost	-0.162E-04*** (0.274E-05)	-0.792E-04*** (0.252E-02)	-0.902E-05*** (0.145E-05)
ASC*knowledge	0.611*** (0.268)	0.436** (0.217)	0.51*** (0.16)
ASC*visit	28. 9 (159E+4)	0.418 (0.685)	0.62 (0.646)
ASC*age	0.24E-02** (0.12E-02)	0.266E-01*** (0.827E-02)	0.27E-01*** (0.681E-02)
ASC*gender	-0.47* (0.255)	-0.333E-01 (0.213)	-0.354E-01** (0.159)
ASC*income	0.239E-04 (0.455E-04)	-0.691E-04* (0.365)	0.552E-04** (0.278E-04)
ASC*education	1.756*** (0.238)	2.883*** (0.309)	2.471*** (0.22)
Education*cost	-0.204E-02 (0.356E-02)	-0.613E-02* (0.332)	-0.535E-02*** (0.232E-02)
Statistic summary			
Relative scale factor ($\mu_{no\text{-}cheaptalk}$)	-	-	1.27
Log likelihood	-568.863	-645.815	-1230.26
Pseudo R^2	0.14	0.17	0.16
Observations	685	745	1430

Notes: (1) The LR test statistic of equal preference parameters is 31.16; the respective critical value at 5% significance level and 14 degrees of freedom (df) df is 23.68. The LR test statistic of equal scale parameters is 3.02; the critical value at 5% significance level and 1 df is 3.84.
(2) Standard deviations are in parenthesis. *** denotes statistical significance at 1% level, ** denotes statistical significance at 5% level and * denotes significance at 10% level.

The Poe et al. (2005) test was conducted to test for differences between the implicit prices derived from the models of choices made with and without cheap talk in the Ha Noi sub-sample. It was found that there was no significant difference between the implicit prices of vegetation and Sarus cranes between the two models while the implicit price for farmers in the cheap talk sub-sample was larger than that derived from the no-cheap talk model (Table 24). This indicates that cheap talk made respondents more concerned about the impacts on local farmers.

Table 24. Test of Differences in Implicit Prices between Cheap Talk and No-cheap Talk Respondent Groups in the Ha Noi Sub-sample

Variables	Implicit prices (Cheap talk)	Implicit prices (No cheap talk)	Proportion of $IP_{cheap\ talk} - IP_{no\ cheap\ talk} > 0$
Vegetation	930 (218 ~ 1646)	608 (65 ~ 1143)	0.23
Sarus cranes	121 (57 ~ 185)	99 (48 ~ 149)	0.29
Farmers	-114 (-146 ~ -81)	-51 (-75 ~ -27)	0.99**

Notes: Confidence intervals at 95%, calculated using Krinsky and Robb (1986) bootstrapping procedure, are given in brackets. ** denotes statistical significance at the 5% level.

4.5 Farming versus Non-farming Populations

The response rate of farming respondents' (80.5%) was higher than that of non-farming respondents (77%). As shown in Table 25, both non-farmers and farmers preferred having fewer households affected and less cost. The number of fish species was insignificant to both sub-samples. Older people with higher incomes chose non-status quo options more often. Gender, knowledge about Tram Chim and future visits to Tram Chim were not significant determinants of respondents' choices.

Some main differences were observed between the two sub-samples. Firstly, non-farmer respondents preferred more vegetation while farmers preferred more birds. Secondly, belief in future generation benefits and potential future visits determined non-farmers' choices while these were insignificant to farmers. It was noted that farmers' choices were influenced a great deal by their ability to afford the payment. About 60% of the farmer respondents explained that they could not afford to pay for an increase in their electricity bills despite their support for wetland improvement for their own benefit and that of their future generations. Thirdly, previous visits made farmers choose change options more frequently while this was not the case for non-farmers. Lastly, non-farming respondents with higher education preferred alternative scenarios.

The Poe et al. (2005) test showed that there was a significant difference in implicit prices between the two sub-samples (Table 26). Non-farming respondents were willing to pay for more vegetation while farming respondents were willing to pay for more birds. Unexpectedly, non-farming respondents were more concerned about the impacts on local farmers than the farming respondents themselves. However, both non-farming and farming respondents were not willing to pay for the proposed wetland biodiversity program, as indicated by insignificant WTP (with confidence intervals at 95% including zero).

Table 25. Farming vs Non-farming Respondents: Multinomial Logit Model Estimates

Variable	Cao Lanh non-farmers		Cao Lanh farmers	
	Model 1	**Model 2**	**Model 1**	**Model 2**
ASC	1.547*** (0.48)	-0.372 (0.634)	0.133 (0.575)	-0.485 (0.723)
Vegetation	0.218E-01*** (0.639E-02)	0.238E-01*** (0.666E-02)	0.0071 (0.0072)	0.718E-02 (0.736E-02)
Birds	0.648E-03 (0.6E-03)	0.827E-03 (0.622E-03)	0.00167*** (0.000725)	0.155E-02** (0.733E-03)
Fish	0.787E-02 (0.91E-02)	0.983E-02 (0.946E-02)	0.0102 (0.0108)	0.888E-02 (0.109E-01)
Farmers	-0.236E-02*** (0.319E-03)	-0.252E-02*** (0.335E-03)	-0.0014*** (0.0004)	-0.136E-02*** (0.359E-03)
Cost	-0.199E-01*** (0.228E-02)	-0.195E-01*** (0.283E-02)	-0.0212*** (0.0027)	-0.214E-01*** (0.281E-02)
ASC*age		0.161E-01* (0.852E-02)		0.185E-01* (0.1E-01)
ASC*gender		0.735E-01 (0.205)		-0.139 (0.208)
ASC*education		0.964*** (0.314)		-0.885 (0.736)
ASC*income		1.125*** (0.293)		0.97 *** (0.32)
ASC*knowledge		0.174 (0.281)		-0.578 (0.404)
ASC*visit		-0.337 (0.227)		0.738** (0.364)
ASC*option		0.439*** (0.217)		0.741E-01 (0.257)
ASC*bequest		1.043*** (0.228)		-0.11 (0.22)
Statistic summary				
Log-likelihood	-500.0347	-462.7466	-409.0976	-398.86
Pseudo-R2	0.13541	0.19	0.09817	0.11
Observations	540	540	490	490

Note: Standard deviations are in parenthesis. *** denotes statistical significance at 1% level, ** denotes statistical significance at 5% level and * denotes significance at 10% level.

Table 26. Farming vs Non-farming Respondents: Implicit Prices and Compensating Surplus

	Cao Lanh non- farming respondents	**Cao Lanh farming respondents**	**Proportion of farming to non-farming > 0**
Implicit prices (VND) of:			
Vegetation	1290 (723 ~ 1898)	0	-
Sarus cranes	0	66 (0.45 ~ 123)	-
Farmers	-119 (-146 ~ -93)	-70 (-95 ~ -45)	0.004**
Compensation surplus (VND)	-10,303 (-21,635 ~ 2,336)	8,700 (-18,951 ~ 35,000)	0.89

Note: Confidence intervals at 95%, calculated using Krinsky and Robb (1986) bootstrapping procedure, are given in brackets. ** denotes statistical significance at the 5% level.

5.0 RESULTS AND SUGGESTIONS FOR FUTURE RESEARCH

This section discusses policy implications regarding the impacts of changes in farm dykes and park dykes on household incomes and wetland values. These are complex issues requiring extensive data on both market and non-market values, some of which are beyond the scope of this research. Therefore, several assumptions have been made to provide indicative information on the costs and benefits of the proposed changes in dykes. Also in this section, the application of CM in the Vietnamese context is discussed to provide some guidance for further application.

5.1 Impacts of Dyke Conversion

There are two main scenarios in the changing of the current dyke systems. In the first scenario, the park dykes of Tram Chim are converted from high to low systems. This would improve the biodiversity of the Tram Chim wetlands but impose costs on local farmers in the adjacent areas by increasing flood durations. In the second scenario, the farm dykes are converted from high to low. This would improve the health of remnant wetlands but impose costs on local farmers resulting from reduced rice productivity and loss of incomes from livestock and orchards. The impacts of these two scenarios are discussed in the following sections.

5.1.1 Park Dyke Conversion

To make a decision about a five-year biodiversity program for Tram Chim involving changes in its park dykes, a cost and benefit analysis (CBA) was deemed necessary. The costs and benefits of this proposed program were estimated using production function and choice modelling analyses.

Changes to park dykes are predicted to increase flood durations in adjacent areas. The following equation was used for calculating impacts of this change on rice productivity.

$$\ln(\text{rice}) = 1.37 + 0.06*\ln(\text{labor}) - 0.0006*\text{flood} + 0.12*\text{soil} - 0.05*\text{disaster} + 0.003*\text{experience} + 0.16*\text{location}$$

Using the average values of the independent variables, it was estimated that if flood duration increased by 10 days a year, rice productivity would decrease by 0.03 tonnes per ha per year. With 50,000 ha that will be affected, the rice loss would be 1,500 tonnes per year. The average rice profit is VND 1.24 million per tonne and the average harvesting costs saved from the reduced rice production would be VND 0.26 million per tonne. Hence, the adjusted rice profit forgone would be VND 0.98 million per tonne. Using this adjusted rice profit, the total loss in rice income would be VND 1,470 million or about USD 91,875 per year, assuming that input choices and costs do not change. Other costs would include biological and hydrological monitoring expenses and engineering costs for dyke reconstruction. The total estimated cost for a five-year program would be about USD 3.4 million (Tram Chim Management Board 2005).

The benefits of the proposed program were estimated based on WTP findings. As discussed in Section 4.3, on average, respondents in Ha Noi were willing to pay USD 2.5 per household for the wetland improvement program, while respondents in Ho Chi Minh City and Cao Lanh showed zero WTP. Two assumptions were used to aggregate overall WTP. First, these sub-samples represented three zones (Zone 1: inside the MRD, Zone 2: on the edge of the MRD, and Zone 3: outside the MRD). Second, seven million households live in these zones; of these, one million residents in Zone 1, three million residents in Zone 2 and three million residents in Zone 3. The aggregation was conducted using two approaches. In the first approach, it was assumed that 30% of non-respondents had the same WTP as the respondents, following the method proposed by Morrison (2000). In the second approach, non-respondents were assumed to have zero WTP (Bennett et al. 1997). The aggregate WTP was calculated using the following equation:

$$\text{WTP total} = \sum_{i=1}^{N} (\text{mean WTP}_i * \text{number of household}_i * \text{response rate}_i)$$

where i = zone index, N= the number of zones

The two approaches provided higher and lower bounds of aggregate willingness to pay values. The higher and lower bound WTPs for the three populations were about USD 5 million and USD 3.94 million respectively. The indicative benefits of the wetland improvement outweighed its costs. The net benefit of the program ranged from USD 0.54 million to USD 1.6 million (Table 27). This suggests that the dyke conversion would generate a net social benefit.

Table 27. Aggregate WTP and Net Social Benefit of Park Dyke Conversion

	Adjusted mean WTP (USD)	**No. of households (million)**	**Response rate (%)**	**Higher bound WTP: extrapolation with adjusted mean WTP (million USD)**	**Lower bound WTP: zero WTP for non-respondents (million USD)**
Zone 1: inside the MRD	0	1	78.6	0	0
Zone 2: on the edge of the MRD	0	3	59.4	0	0
Zone 3: outside the MRD	2.5	3	52.5	5.0	3.94
Total WTP				5.0	3.94
Cost				3.4	3.4
Net social benefit				1.6	0.54

To realise such a benefit, the conversion of the park dykes can be implemented using funds raised from urban households outside the MRD. As the appropriateness of the provision method of an increase in the electricity bill used in this study is tentative (based only on focus group feedback), further studies on alternative provision methods are needed. This funding will be used for compensating the local farmers for their forgone incomes as calculated in this study. However, in the long run, the farmers will benefit from the park dyke conversion due to improved fish stock, reduced invasive *mimosa pigra* and eco-tourism (Tram Chim Management Board 2005). These potential benefits can be used as incentives for farmers to accept the dyke conversion. A social impact assessment on these potential benefits would complement this study in justifying the dyke conversion.

5.1.2 Farm Dyke Conversion

With respect to the farm dyke conversion, as opposed to the park dyke scenario, the findings of this study only provide inputs based on a partial CBA. Farm dyke conversion involves biophysical and socio-economic impacts on a large scale. To understand such impacts would require extensive data beyond the scope of this study. The conversion from high to low dykes would involve costs and benefits. The costs include reduced household incomes and forgone benefits of high dykes such as daily life convenience, reduced flood-related accidents and avoided infrastructure damage. To estimate the loss in rice income, the following model was established based on findings presented in Table 8:

$$\text{Ln (rice)} = 1.32 + 0.06*\ln(\text{labor}) - 0.04*\text{disaster} + 0.09*\text{soil} + 0.003*\text{experience} + 0.16*\text{location} + 0.04*\text{dyke}$$

Putting the average values of the independent variables in the high dyke scenario into this model, the predicted loss in rice productivity when converting from high to low dykes came to 0.24 tonnes per ha. On average, each household in high dyke areas has 1.89 ha of rice cultivation. Therefore, the reduction in rice production would be 0.45 tonnes per household per year. With the adjusted rice profit forgone of VND 0.98 million per tonne (re: section 5.1.1), it is estimated that the conversion from high to low dykes would reduce rice incomes by VND 0.44 million per household per year. With a loss of income from livestock being VND 15 million per household per year (re: section 3.3), the estimated income loss of the dyke conversion would be VND 15.44 million per household (growing rice and owing livestock) per year.

Assuming that the total number of households in high dyke areas in the MRD is 100,000 of which 38% have livestock (as found in this case study), the estimated total loss in incomes would be about VND 614 billion [(0.44 x 100,000) + (15 x 38,000)] or USD 38.4 million, representing the costs of converting high dykes to low ones. This figure would be higher if reduced incomes from orchards, costs of forgone benefits of high dykes such as daily life convenience; reduced flood-related accidents and avoided infrastructure damage; and engineering costs are taken into account. However, farmers can benefit from the conversion of high to low dykes if they develop aquaculture and capture fisheries (Hoi 2005). Therefore, the costs of the dyke conversion would be lower if farmers were to apply aquaculture and capture fisheries as alternatives to rice and orchard production and livestock.

The benefits of the dyke conversion include increased wetland biodiversity, improved surface water quality and reduced pests (Tien Giang Department of Natural Resources and Environment 2002) – however, only the first was examined in this study. The values of improved wetland biodiversity of the proposed dyke conversion were estimated using a benefit extrapolation method, assuming that the biodiversity value per ha estimates for the 9,000 ha of Tram Chim were equal to the values of other wetlands in the MRD. There are 95,238 ha of natural wetlands with high biodiversity in the MRD (Buckton et al. 1999). Using the value estimates of Tram Chim presented in Section 5.1.1, the biodiversity values of all wetlands in the MRD were estimated at USD 41.7 million and USD 53 million for lower and higher bounds respectively (Table 28). Therefore, the net social benefit would range from about USD 3.3 million to USD 14.6 million.

However, these should be interpreted as indicative findings only for several reasons. Firstly, the biodiversity values estimated in this study were for a relatively small area of the wetlands, as opposed to the large areas of wetlands in the MRD. Secondly, this study was only a partial CBA covering biodiversity benefits and rice loss costs. Other costs and benefits were not included. Thirdly, the results of this partial CBA were derived from a partial equilibrium rather than a general equilibrium analysis. The impacts of the dyke conversion may involve other socio-economic impacts that are beyond the scope of this research. Further research is needed to evaluate other impacts of the proposed farm dyke conversion in the MRD.

Table 28. Net Social Benefit of Farm Dyke Conversion

	Higher bound value (million USD)	**Lower bound value (million USD)**
Benefit		
- Tram Chim wetlands	5	3.94
- Other MRD wetlands	53	41.7
Costs	37	37
Net social benefit	16	4.7

5.2 Application of Choice Modelling in the Vietnamese Context

As environmental non-market valuation is relatively new to Vietnam, the lessons learnt in this study would be helpful for future CM applications in the country. Some points about the questionnaire design in the Vietnamese context should be noted. For one thing, instead of using the term ‘referendum’, the questionnaire should explain how the voting system works. This is because the term ‘referendum’ is not familiar to the respondents as Vietnam has not had a referendum in the past 60 years (Tuoi Tre 2006). Secondly, the example of making choices when building a house was found to help respondents better comprehend the relevance of attributes in the choice sets they faced.

Thirdly, pictures were found to help explain the issues and choices much better than text. Fourthly, the issue of whether an increase in the electricity bill is an appropriate payment vehicle remains inconclusive. Similar to Thuy’s (2006) findings, while focus groups thought that the electricity bill would be best, about 15% of the respondents in the survey did not support this payment vehicle. Lastly, unlike Aadland and Caplan's (2006) findings, the test of cheap talk in this research showed that a short, neutral cheap talk script can reduce respondents’ WTP. However, this effect was observed only for respondents who lived far from the study site. Therefore, caution needs to be exercised when using cheap talk for different populations.

Another issue for this CM application was the mode of survey. As discussed in Section 2.3.2, personal interviews were undertaken. In selecting options in each choice set, respondents were given some time to think and make up their minds while enumerators kept silent. This was designed to take advantage of both the personal interview and drop off-pick up methods. However, it is unclear whether this personal interview with adequate time for respondents to think about their choices worked better than the drop off-pick up method. In the survey, some respondents asked for more time to think about the choice sets while others wanted to finish the questionnaire as quickly as possible. A study of the influence of the drop off-pick up and personal interview techniques on respondents’ choices would provide more insights into this issue.

5.3 Suggestions for Future Research

As discussed earlier, several potential research areas have been identified. Firstly, research could involve investigating other benefits and costs of the farm dyke conversion from high to low systems. The benefits could include surface water improvement and reduced pests due to the flushing out effects of natural flooding. A non-market valuation of these benefits conducted for a large-scale wetland improvement project would provide more insights into the benefits of dyke conversion. Similarly, studies about other costs imposed on local people such as daily inconvenience due to prolonged flooding and infrastructure damage would be informative and useful. As a result, a comprehensive cost-benefit analysis should be conducted to further assist policy-making processes.

Secondly, research could further explore methodological issues in the application of CM in the Vietnamese context. These issues could include the effects of payment vehicles and modes of survey on WTP. Thirdly, future studies could focus on cost-benefit analyses of using high and low dykes as alternatives in sea level rise adaptation – the MRD in Vietnam is one of the most vulnerable regions in the world to sea level rise (Dasgupta et al. 2006). A bio-economic model incorporating the ecological and socio-economic impacts of dykes in the context of sea level rise would provide helpful information for identifying suitable adaptation strategies.

6.0 CONCLUSIONS

The ad hoc development of dykes in the MRD has resulted in wetland degradation. To deal with this problem, several proposals by wetland ecologists have been put forward to the government. These proposed programs involve changing from high to low systems for both farm and park dykes. Information on the impacts of the change in dykes on wetland values, especially the CBA and determining the amount of compensation to be paid to the local people affected, is helpful to the decision-making process,. However, at present, there is limited information on the possible impacts of the dyke change on wetland values. This research helps fill this information gap by estimating the impacts of such change on rice values and biodiversity values, using a rice production function approach and environmental choice modelling.

The Tram Chim National Park and its adjacent areas in the Plain of Reeds were selected as the study site for this research. To estimate the impacts of a change in dyke height on rice values, farm surveys were conducted on households in Dong Thap, Tien Giang and Long An provinces. To estimate the impacts on biodiversity values, personal interviews were performed in three zones: inside the MRD, on the edge of the MRD and outside the MRD. Cao Lanh, Ho Chi Minh City and Ha Noi were selected as survey cities for these three zones. The samples of Ho Chi Minh and Ha Noi were further split into sub-samples to test the effect of a short, neutral cheap talk script on the value estimates.

It was found that the proposed changes in dyke and wetland management of Tram Chim would reduce rice yields by 0.03 tonnes per ha per year or 1,500 tonnes per year for local farmers in adjacent areas. This income loss of about USD 91,875 per year, together with compensation for “farmer changing livelihood” costs, and engineering costs makes the total costs of the proposed program USD 3.4 million for a five-year period (Tram Chim Management Board 2005). On the other hand, respondents are willing to pay for biodiversity values of Tram Chim resulting from changes in its dyke and wetland management. The aggregated values of the three zones mentioned above range from USD 3.94 million to USD 5 million, suggesting that park dyke conversion can generate a net social benefit.

It was also found that the conversion from high to low farm dykes would reduce rice yields by 0.24 tonnes per ha per year or VND 0.98 million per household per year. In addition, it would reduce other incomes from livestock and orchards. It would also impose costs from increased infrastructure damage, reduced daily life convenience and increased flood-related accidents. Taking into account only the reduced rice and livestock incomes, the cost of the dyke conversion would be VND 15.4 million per household per year, and VND 614 billion or USD 38.4 million for the whole MRD. These impacts are not significantly different between upstream and downstream farmers. Although further research is needed to have more comprehensive figures, taking into account the benefits of improved biodiversity and costs of reduced rice production, it is estimated that the net benefits of the wetland improvement resulting from the farm dyke conversion range from USD 3.3 million to USD 14.6 million.

The WTP for wetland improvement depends on a number of factors. Older, more educated and wealthier respondents had a higher WTP. Those who lived further away from the wetland site, had knowledge about the wetland, and had option and bequest values about the wetland also showed a higher WTP. However, respondents had a lower

WTP if they had visited the site before. The WTP was also reduced by a short, neutral cheap talk script that explicitly told the respondents about hypothetical bias problems and substitution options for the wetlands, and reminded them about their budget constraints. Although cheap talk was found to reduce WTP, its effect was only observed in respondents living far from the site. More specifically, cheap talk made respondents more concerned about the negative impacts on local farmers. This effect was conveyed through changing respondents' preferences rather than scale parameters. It was also found that the WTP of farming respondents was not significantly different from that of non-farming respondents.

The findings of this research are helpful for policy-making on dyke management in the MRD. It has been shown that the conversion of park dykes around wetland protected areas like the Tram Chim National Park would improve social welfare. With respect to the farm dykes, although more studies are needed for better understanding of the impacts of the dyke changes, the findings of this research indicate that the biodiversity benefits of the change outweigh the costs of reduced rice production. Also, the information presented in this research can be used for determining the level of compensation to be paid to local farmers for rice income losses resulting from the change in dyke management strategies. Furthermore, the information can be used for the assessment of the impacts of sea level rise and the potential for adaptation in the MRD.

In conclusion, this research has shed some light on the impacts of a change in dyke management on wetland market and non-market values. Although further research is needed to provide more insight into the costs and benefits of such a change, the findings of a partial CBA carried out in this research suggest that wetland improvement resulting from the dyke change can generate net social benefits to society. In addition, the research contributes to existing knowledge on the application of CM in wetland non-market valuation in Vietnam. Furthermore, it identifies key future research areas involving wetland non-market valuation and wetland management. These would contribute to not only improved wetland management in the MRD but also to the sustainable development of the whole region.

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